higher education & training

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ENGINEERING PHYSICS N6

(15070126)

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This question paper consists of 6 pages and a formula sheet of 2 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING PHYSICS N6
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Start each question on a new page.
5. Use only a black or blue pen.
6. Write neatly and legibly.

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QUESTION 1: SOUND

1.1 List FIVE characteristics of a sound wave. (5)

1.2 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.2.1–1.2.5) in the ANSWER BOOK.

1.2.1 The pitch of a sound depends on the amplitude of the wave.

1.2.2 Potential energy is the ability of a body to do work due to its motion.

1.2.3 When a frequency is developing for the first time from a fundamental tone it is called an overtone.

1.2.4 The Doppler effect occurs when a source moves while transmitting sound because the waves in front will be compressed and at the back they will be more drawn out.

1.2.5 Pure tone is free of overtones.

(5 × 1) (5)

1.3 The horn of an electric train is sounded at a frequency of 1 200 Hz. The speed of sound in air is 330 m/s.

Calculate:

1.3.1 The frequency heard by a student standing on a platform while a train approaches her at a speed of 80 km/h (3)

1.3.2 The frequency heard by the student when the train is just passing her (2)

1.3.3 The frequency heard by the student if she runs after the train at 18 km/h (2)

1.4 In a Kundt dust-tube experiment the tube is used to determine the velocity of sound in a steel bar. The steel-bar rod, 0,8 m long and clamped at its midpoint, is set into longitudinal oscillation. The distance between the dust heaps in the tube is 60 mm. The velocity of sound in air is 334 m/s.

Determine:

1.4.1 The velocity of sound in the rod

1.4.2 The frequency of the note emitted by the rod

(2 × 2) (4)

1.5 A learner dropped an object into a well and after five seconds the sound of the object hitting the water is heard.

How deep is the well? (4)

[25]

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QUESTION 2: THERMODYNAMICS

2.1 Complete the following paragraph by choosing a word or words from the list below. Write only the answer next to the question number (2.1.1–2.1.6) in the ANSWER BOOK. Each word may only be used once.

closed tube; constant; work done; freezing point; heat; colder body; closed system; energy; isometric process; temperature; volume; gas

The first law of thermodynamics states that in a (2.1.1) ... the total amount of energy is (2.1.2) … The second law of thermodynamics states that it is impossible for a machine to withdraw (2.1.3) ... and to convert all of it into (2.1.4) … without a portion always flowing to a (2.1.5) ... without doing work. The third law of thermodynamics says that the absolute (2.1.6) ... can be approached, but cannot be reached. (6 × ½) (3)

2.2 A steam engine operates between a boiler temperature of 185 °C and a condenser temperature of 64 °C and delivers 8,5 kW of power. Its efficiency is 38% that of an ideal engine operating between these temperature limits.

Calculate:

2.2.1 The actual efficiency of the engine

2.2.2 The power absorbed by the boiler

(2 × 3) (6)

2.3 Three ice cubes at -8 °C are placed in a cup of tea. Each ice cube has a mass of 14 g and is placed in a tea cup of 470 g at a temperature of 96 °C. The specific latent heat of the fusion of ice is equal to 333 J/g and the specific heat capacity of ice is equal to 2,2 kJ/kg.K.

Determine the final equilibrium temperature if the heat capacity of tea is the same as water. (10)

2.4 2½ kg of a gas with a temperature of 58 °C and a pressure of 180 kPa is compressed adiabatically to a pressure of 1 250 kPa. Cp = 865 J/kg.°C and Cv = 625 J/kg.°C.

Calculate the work done during compression. (6)

[25]

QUESTION 3: ELECTROSTATICS

3.1 Complete the following paragraph by choosing a word or words from the list below. Write only the answer next to the question number (3.1.1–3.1.6) in the ANSWER BOOK. Each word may only be used once.

force; two point; product; magnitude; square; attraction; straight line; electrostatic; proportional

Coulomb's law states that the (3.1.1) ... of the electrostatic force of (3.1.2) … or repulsion between (3.1.3) … charges is directly proportional to the (3.1.4) … of the magnitudes of charges and inversely proportional to the (3.1.5) … of the distance between them. The force is along the (3.1.6) … joining them. (6 × ½) (3)

3.2 Define *electrical field strength*. (3)

3.3 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (3.3.1–3.3.3) in the ANSWER BOOK.

3.3.1 A line of force represents the path a positively charged particle will follow in an electrical field.

3.3.2 A particle can travel in only one direction at any point.

3.3.3 Magnetic lines flow from south to north.

(3 × 1) (3)

3.4 Two positive point charges of 12,5 µC each are 135 mm apart in a vacuum.

Determine:

3.4.1 The force that is created between the two positive charges

3.4.2 The force and the ratio if the magnitude of the one charge is doubled

3.4.3 How the force will be influenced if the distance is to be doubled

(3 × 2) (6)

3.5 Two capacitors with capacities of 5,8 pF and 11,6 pF respectively are connected in series. A voltage of 900 V is applied across the combination.

Determine:

3.5.1 The capacity of the series connection

3.5.2 The charge in each capacitor

3.5.3 The potential difference across each capacitor

3.5.4 The electrical energy stored in the combination

(4 × 2) (8)

3.6 How is the number of feed lines in an area determined? (2)

[25]

QUESTION 4: ATOMIC PHYSICS

4.1 Define the FOUR characteristics of an electron. (4)

4.2 Explain *thermionic emission*. (2)

4.3 Name the instrument used to determine the mass of the parts of a certain substance. (1)

4.4 A 2,5 µF television-set capacitor is subjected to a 3 500 V potential difference across its terminals.

Determine the energy stored in the capacitor. (2)

4.5 A 24 volt battery is tested with a rate of 18 coulomb per second.

Determine:

4.5.1 The amount of power needed to charge the battery

4.5.2 The amount of energy stored in the battery if it is charged for one hour

(2 × 2) (4)

4.6 Determine the kinetic energy in eV of an electron with a velocity of 10^7 m/s. Take the mass of an electron as $9,6 \times 10^{-31}$ kg. (2)

4.7 Some students are doing research on a metal and the following were documented by using a red light on the metal. The red light with wavelength $8,5 \times 10^7$ m is shone onto a particular metal. The minimum amount of energy required to release an electron from this metal is $1,5 \times 10^{-19}$ J.

4.7.1 Determine the energy of a photon of this red light. (2)

4.7.2 Determine the maximum kinetic energy of each ejected electron. (2)

4.8 A hydrogen atom consists of a proton (charge +e) and an electron (charge -e) that are an average of $4,85 \times 10^{-11}$ m apart.

Calculate the attractive force between them. (3)

4.9 Write down the number of protons, neutrons and electrons of the following:

$$\frac{37}{56}\text{Ba}$$

(3)
[25]

TOTAL: 100

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FORMULA SHEET

The list is not necessarily complete. Any other applicable formula may also be used.

$$E = \frac{T_1 - T_2}{T_1} = 100\%$$

$$\frac{\gamma P}{\rho} = \frac{\gamma RT}{m} = v^2$$

$$\eta = \frac{W}{Q_1} = 1 - \frac{T_2}{T_1} \times 100\%$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$W = m.C_v(T_2 - T_1)$$

$$Q = W = P_1V_1 \ln \frac{V_2}{V_1}$$

$$S_f = 4{,}187 \ln \frac{T_f}{273}$$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$$

$$W = \frac{P_1V_1 - P_2V_2}{\gamma - 1}$$

$$PV = mRT$$

$$Q_1 = m_1 c \Delta T$$

$$Q = mL_v$$

$$U = mC_v(T_2 - T_1)$$

$$\left(\frac{V_2}{V_1}\right)^{\gamma-1} = \frac{T_1}{T_2}$$

$$\gamma = \frac{C_p}{C_v}$$

$$R = C_p - C_v$$

$$W = mRT_1 \ln\left(\frac{P_1}{P_2}\right)$$

$$P_1V_1^{\gamma} = P_2V_2^{\gamma}$$

$$W = mR \ln \frac{V_1}{V_2}(T_1 - T_2)$$

$$f' = \frac{fV}{V - v}$$

$$f' = \frac{F(V + v)}{V}$$

$$v = \lambda f$$

$$f = \frac{C}{2l}$$

$$V = \sqrt{\frac{\gamma P}{\rho}} = \sqrt{\frac{\gamma RT}{m}}$$

$$v = \sqrt{\frac{F}{\mu}}$$

$$\frac{V_1}{\lambda_1} = \frac{V_2}{\lambda_2}$$

$$f' = f\left(\frac{v \pm v_o}{v \pm v_z}\right)$$

$$f = \frac{1}{2L}\sqrt{\frac{P}{m}}$$

$$E = \frac{F}{Q_1} = \frac{Q}{4\,\pi\, e_o r^2}$$

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$$W = QV$$

$$E = \frac{mg}{q}$$

$$E_k = W = Vq$$

$$Q = CV$$

$$E = hf$$

$$F = qE$$

$$E = \frac{1}{2}CV^2$$

$$V = \frac{mgr}{Q}$$

$$t = RC$$

$$S = \frac{W}{F}$$

$$E_k = hf - W$$

$$r = \frac{Q}{4\pi \in_o r}$$

$$v = \frac{kQ}{r}$$

$$C = \in_r . \in_o . \frac{A}{d}$$

$$F = \frac{kq_1q_2}{r^2}$$

$$E_k = QV$$

$$e = \frac{v}{d}$$

$$\frac{1}{c} = \frac{1}{c_1} + \frac{1}{c_2}$$

$$I = \frac{Q}{t}$$

$$v = \lambda f$$

$$W = \frac{1}{2}QV$$

$$m = EQ = \left(\frac{V}{r}\right)Q$$

$$C = k \in_o \frac{A}{d}$$

$$a = \frac{F}{m} = \frac{Eq}{m} = \frac{Vq}{S_m}$$

$$W = Vq = \frac{1}{2}mv^2$$

$$r = \sqrt{\frac{kq_1q_2}{F}}$$

$$\sigma = \frac{Q}{4\pi r^2}$$

$$W = \frac{1}{2}cv^2$$

$$T = \frac{1}{\lambda} . \ln 2$$

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